PRESCRIBED FORMAT FOR SUBMISSION OF RESEARCH PROPOSAL FOR TOPIC APPROVAL

Proposal for topic approval to be submitted to the
University of Mumbai for the Degree of Ph.D.[Management Studies]
in the subject of Marketing

Title of the topic		TO STUDY THE "IMPACT OF INDUSTRY 4.0 ON PERFORMANCE OF INDIAN AUTO ANCILLARIES & ALLIED MANUFACTURING COMPANIES"
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"To Study the Impact of Industry 4.0 on Performance of Indian Auto Ancillaries & Allied Manufacturing Companies."

A

PROPOSAL

SUBMITTED TO

UNIVERSITY OF MUMBAI

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN MANAGEMENT

by

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UNDER THE GUIDANCE OF

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1.0. Introduction

1.1. What Is Industry 4.0

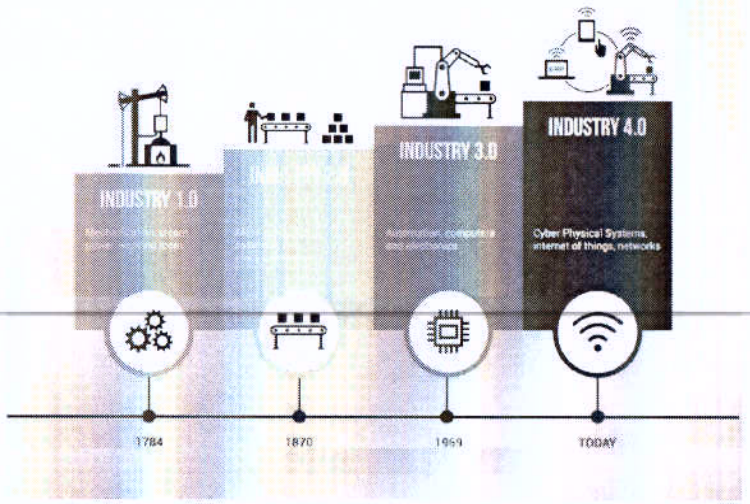
"The Fourth Industrial Revolution is not about new Apps or new technologies. It is about a new era, new ways of thinking and new ways of doing business." — **Nicky Verd (2019).**

Industrialization and mechanization have gone through continuous improvement as our pursuit for improved efficiency, improved quality and higher profitability

What started from mechanization to mass production technology to automation is now powered by the Industrial Internet of Things (IIoT) and cyber-physical systems – smart, autonomous systems that use computer-based algorithms to monitor and control physical things like machinery, robots, and vehicles. This is known as Industry 4.0

In Industry 4.0 (***as shown in Figure 1***) computers and automation will come together in an altogether a new way, with robotics connected remotely to computer systems equipped with machine learning algorithms that can control the robotics with minimum human support.

Figure 1 What is Industry 4.0



***Source: Internet (www.trunovate.com, author : Jolene Amit)*

Industry 4.0 has highly intelligent connected systems that create a fully digital value chain. It particularly is based on cyber physical production systems that integrate communications, IT, data and physical elements and wherein these systems transform the traditional plants into smart factories. Here the objective is that the machines talk to other machines and products and information is processed and distributed in real time resulting in profound changes to the entire industrial ecosystem.

Considering the impact of transformation, there are some key elements those constitute the cornerstones of Industry 4.0 (Vaidya et al. 2018) which includes Industrial Internet of Things (IIOT), Big Data Analytics (Bigdata), Autonomous Robots & Artificial Intelligence (AI), Digital Simulation (Simulation), System Integration, Cyber Physical Systems (CPS), Cloud computing (Cloud), Additive Manufacturing (AM) and Augmented Reality (AR).

As per **Association for Advanced Automation (AAA)** Industry 4.0 is the current trend of automation and data exchange in manufacturing technologies, including cyber-physical systems. The goal is to enable autonomous decision-making processes, monitor assets and processes in real-time, and enable equally real-time connected value creation networks through early involvement of stakeholders, and vertical and horizontal integration. The cyber-physical systems are the basis and enable new capabilities in areas such as product design, prototyping and development, remote control, services and diagnosis, condition monitoring, proactive and predictive maintenance, track and trace, structural health and systems health monitoring, planning, innovation capability, agility, real-time applications and more.

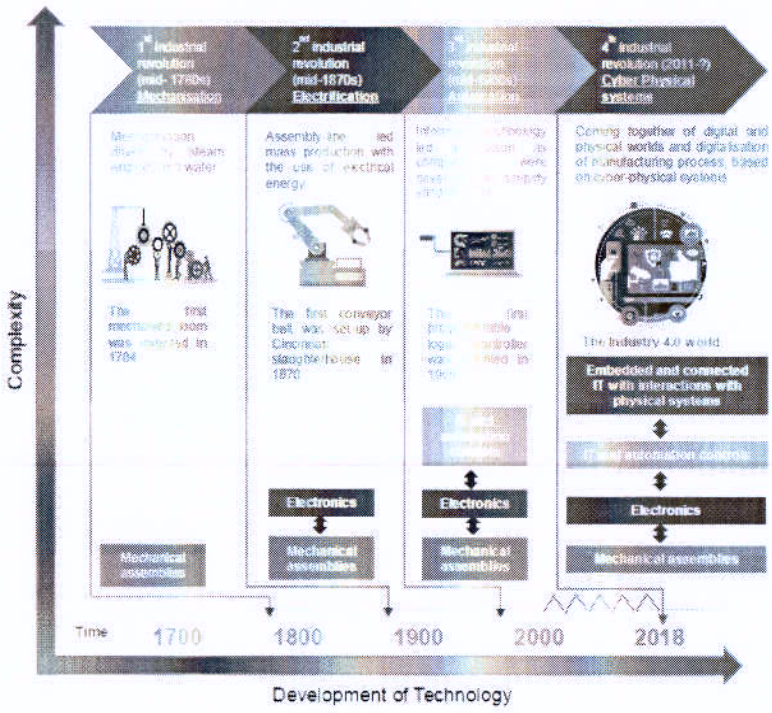
1.2. Evolution of Industry 4.0

The expression "Industry 4.0" was coined in Germany in relation to the digital transformation in the manufacturing industry. This expression became the buzzword around the world. The evolution of Industrial revolution (***as shown in Figure 2***) has been phenomenal

1. **The First Industrial Revolution** was triggered by water and steam power, marking the transition from human labor to mechanical manufacturing. Toynbee (1884) coined the term "Industrial Revolution" by observing changes during the period 1760 to 1840. The period marked the end of the 18th century.
2. The **Second Industrial Revolution** was built on electric power to facilitate mass production based on division of labor. It happened at the start of the 20th century.

3. The **Third Industrial Revolution** used electronics and information technology to automate manufacturing. It began during the early 1970's.
4. **The Fourth Industrial Revolution** is the current trend of automation and data exchange in manufacturing technologies (Arthur2020). The dominant technologies of Industry 4.0 will be IT, electronics, and robotics. It will also embrace other knowledge areas such as biotech and nano-tech. It is indeed based on the cyber-physical system (CPS).

Figure 2 Evolution of Industry 4.0



Source: All India Management Association (AIMA) & KPMG Report on Industry 4.0

1.3. Components of Industry 4.0

The following components of Industry 4.0 are shown in the list below:

1. **Robotics and Artificial Intelligence (AI)** deals with design, construction, operation and application of the robots and are generally used on tasks which are repetitive and thus allow workers to focus on more intensive duties. Enterprises that aim to have Industry 4.0 deployment also consider integrating robotics into its operations.

As per Robotics & Automation News Artificial Intelligence (AI), robotics have the ability to increase labour productivity.

2. **Big Data** is extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations for enhanced insight, decision making and process automation. In Industry 4.0 the amount of information produced by IoT and today's manufacturing systems must be translated into actionable ideas. That's why Big Data classifies the information collected and draws relevant conclusions that help improve companies' operations in the following ways.

3. **Augmented Reality (AR)** is integral part of Industry 4.0 and it enables users to access digital information and overlay that information with the physical world which is basically interactive experience of the real-world environment (eg. Touchscreen, Speech Recognition, 3D Models) This technology can bring huge support for maintenance works in business due to reduced time needed for maintenance works and reduction of potential errors in maintenance works. It can also help effectively for 3D modelling & prototyping, Training, Customer demonstration and simulations.

4. **Additive manufacturing (3D Printing)** is commonly known as 3D printing, additive manufacturing is the process of building an object by depositing material in multiple layers. Industry 4.0 provides the technological infrastructure for manufacturing enterprises to use 3D technology at scale, producing smaller numbers of more customized products. Because additive technology can be done on demand, production time for those customized products is also significantly shorter. One hallmark of a true Industry 4.0 enterprise, therefore, is the robust integration of additive manufacturing throughout the supply chain, not only to produce products for end users, but also for the manufacture of customized machine parts within the supply chain itself.

5. **Cloud Computing** constantly produces insights in real time, requiring incredible speed and precision, not to mention the capacity for instant access and end to end visibility. Those demands are best met in the Cloud. As Cloud technology continues to improve, the Industry

4.0 enterprise will increasingly deploy it for data management and functionality. Cloud also offers the necessary agility for the supply chain in Industry 4.0

6. **Cybersecurity** becomes important due to the increased dependence on interconnected devices and data leaves the supply chain incredibly vulnerable. The first step for supply chain leaders is to establish robust communication and connectivity protocols that can be easily adopted across the enterprise. These protocols are a strong line of defense, but they must be complemented and supported by rigorous identity access management that protect all manufacturing lines and critical industrial systems. Thus, the Industry 4.0 enterprise must constantly make cybersecurity a top priority.

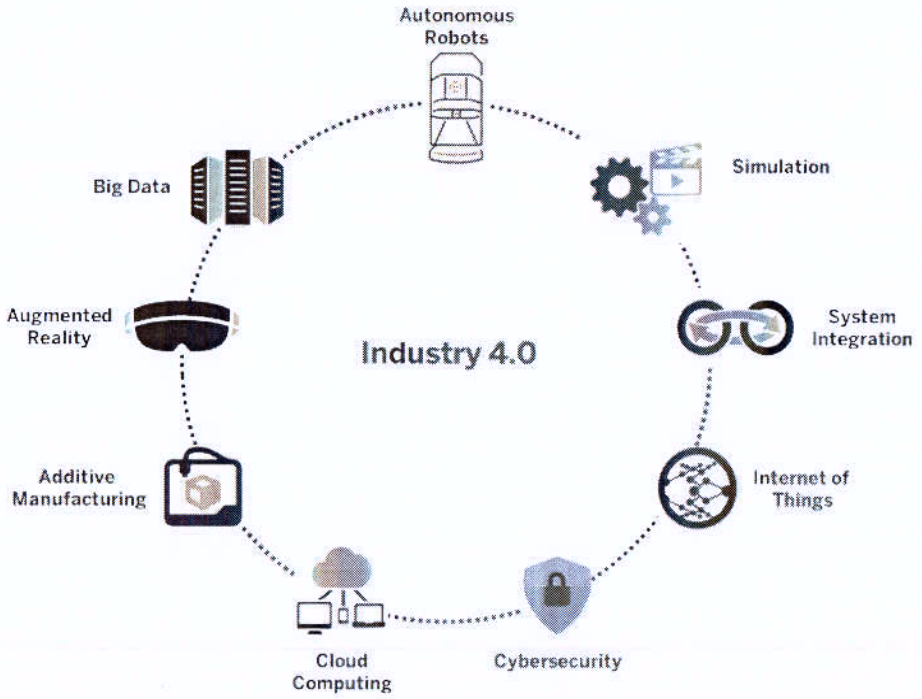
7. **Internet of Things (IoT)** refers to computing technology embedded in devices, which can communicate with other devices and people through the internet. As per Association for Advanced Automation (AAA), Internet of Things (IoT) enables machinery and objects like sensors and networks to communicate. Such integration makes it easy for cyber-physical systems to work and solve problems independently.
   The Industry 4.0 supply chain fully leverages the IoT (Internet of Things) for streamlined, agile operations with far greater visibility and transparency.

8. **System Integration**: System Integration is a process commonly implemented in the fields of engineering and information technology. It involves the combination of various computing systems and software packages in order to create a larger system, and this is what drives Industry 4.0 to work at its optimum. System Integration increases value to a system by creating new functionalities through the combination of sub-systems and software applications.

9. **Simulations Modelling** is a way of running a real or virtual process or a system to find out or guess the output of the modelled system or process. Simulations are done by using real-time data to represent the real world in a simulation model, which include humans, products and machines. Therefore, operators are able to optimize the machine settings in a virtual simulated situation before implementing in the physical world. Furthermore, advanced

artificial intelligence (cognitive) on process control, including autonomous adjustments to the operation systems (self-organisation) can also be done through simulations.

Figure 3 : Some of the Components of Industry 4.0



***Source: Internet (smequest.com /* INDUSTRY4.0 (smequest.com))

1.4. Benefits of Industry 4.0:

The main benefit of Industry 4.0 is increased productivity, safety, increase efficiency, flexibility and competitiveness (Miroslav Mindas & Slavomir Bednar ,2016).

A survey done by The Business Development Bank of Canada (BDC) under title "Industry 4.0: The New Industrial Revolution" has found that manufacturing companies in Canada which has implemented Industry 4.0 are experiencing some real time benefits in area of productivity, reduced downtime, Overall Equipment Efficiency (OEE), operating cost, predictive maintenance, quality control and faster innovation.

According to study by Mckinsey under Title "Industry 4.0: Reinvigorating ASEAN Manufacturing for the Future" there are Productivity gains and OEE improvements for different industries
A report by KPMG and All India Management Association (AIMA) on "Industry 4.0: India Inc Gearing up for Change" highlights following as some of the key benefits of Industry 4.0

- **Improved Productivity (reduce cycle time) and Higher efficiency**: Solutions to eliminate errors and wastage, Higher production and shortened cycle time
- **Agility and Flexibility** which involves large variability in Production control, Large variability in production control can also be achieved through this
- **Competitiveness:** This can come through lower manufacturing costs, use of innovative solutions and flexible response to fluctuation and demand
- **Profitability**: This can come optimized processes and efficiencies, advantages of mass production
- **Improved Quality Control:** Poor quality reduction can eliminate cost of non-conformity
- **Improved Safety**: sensors to ensure worker safety and immediate reaction to any event
- **Ecological benefits**: Use of green solutions and optimal usage of resources
- **Inventory Reduction**: accurate forecasting helps in inventory reduction
- **Reduced Downtime & Plant Maintenance Cost** : Predictive analysis helps to reduce downtime and similarly additive manufacturing reduces maintenance cost

1.5. India's Readiness for Industry 4.0

It is necessary to assess the Industry 4.0 readiness of industrial enterprises & manufacturing sector. The manufacture sector has to check their own preparedness as well preparedness of the country to have Network Readiness, Favorable Government Policies, Demand, adoption of IOT, adoption of Robotics, Adoption of Big Data and Skilled Labor.

According to Indian Brand Equity Foundation (IBEF), the Government of India has set an ambitious target of increasing the contribution of manufacturing output to 25 percent of Gross Domestic Product (GDP) by 2025, from 16 percent currently. Many Indian Small & Medium

Enterprises (SME) still operate in an Industry 3.0 or even a 2.0 environment, with modern IT systems limited to administration functions rather than application within production processes.

As per Study of Grand Thornton & Confederation of Indian Industry (CII) on India's Readiness for Industry 4.0 , , Internet of Things (IoT) being one of the most important aspects of Industry 4.0 for India is expected to capture close to 20 percent share in global IoT market in the next five years. Also according to Indian Brand Equity Foundation (IBEF) forecast, the IoT market in India grew at a Compounded Annual Growth Rate (CAGR) of more than 28 percent during 2015-2020.

The Joint report of KPMG & All India Management Association (AIMA) on Industry 4.0: India Inc Gearing Up for Change mentions that Big Data Analytics Markets will grow at Compounded Annual Growth Rate (CAGR) of 26% to INR 1.03 Lac crores by 2025. This report also mentions that Indian Automotive sector is at the forefront of adopting Industry 4.0.

1.6. Industry 4.0 & Global Adoption

As per paper submitted by Mr.T.P.Bhat on "Industrial, Trade and Investment Policies: Pathways to Industrialization" many countries have advanced in adoption of Industry 4.0 which includes United States of America (USA), United Kingdom (UK), China , Japan and many countries in European Union (EU).

Also, as per study done by Euromonitor (as shown in figure 6) on preparedness of various countries, Germany, Ireland, Austria, Singapore & Malaysia are most ready to adopt new production methods. India currently does not figure in Top 25 countries which are ready for Implementing Industry 4.0 as per study of Euromonitor.com .

1.7. Significance of Study

"Industry 4.0" was a term coined in Germany in 2011 to describe how this will revolutionize the organization of global value chains by enabling smart factories (Klaus S, 2016).

Adoption of Industry 4.0 is at a very nascent stage and adoption of new technology will come with its advantages and challenges. Many countries have advanced in adoption of Industry 4.0 which includes United States of America (USA), United Kingdom (UK), China , Japan (T.P.Bhat, 2020) Several reports, study and article has been done on challenges of Industry 4.0 in India and preparedness of India for Industry 4.0 and study is yet to measure the benefits of Industry 4.0 for productivity, quality, maintenance, delivery, safety for India. There has little clarity in various studies on decision making criteria for implementing Industry 4.0 in India.

Study has been done through DEMATEL Approach for Evaluation Key Challenges to Industry 4.0 (Ankur A, Sumit G, 2019) and also on demand on Education for Industry 4.0 (Krishnan U, Igor J, Debra F, 2018). There has been Study of Innovative Journey with respect to Industry 4.0 from Germany to India (Pankaj K, 2019) and there has been paper on Overview, Practices and role of Management accountants towards Industry 4.0 (Batani Raghavendra R,2019), studies has been done to highlight the impact of Industry 4.0 and need for upskilling (Balwant S, Ishwar Chandra, 2019).

2. Review of Literature:

Sr.No.	Reviewed by	Key Components and Scope	Research Gap
1	The Fourth Industrial Revolution (I4.0) in India: Challenges & Opportunities (Vijay J ,Ravindra M, 2019)	The paper highlights Challenges and Opportunities for Industry 4.0 in India along with its Advantages and role of Government Policies towards adoption	The Paper highlights Challenges & Opportunities for Industry 4.0 in India and does not have benefits and key factors for consideration in scope
2	Industry 4.0 and Future of Work in India (Balwant S, Ishwar Chandra, 2019)	Paper suggest that threatening of jobs is inescapable, but this will require training-retraining of people in the newer forms of skills that is critical policy challenge to the government and other stakeholders such as companies and other employers	The paper covers the challenges faced by the employment sectors and need for newer forms of skills and does not cover benefits of key components of Industry 4.0 and does not cover employment generation due to scale and competitiveness in scope
3	Swarnima Chauhan, Priyanka Mehra, Ankita Dasot (Grant Thornton, 2018)	The report gives inputs on readiness of various countries for Industry 4.0 including India and also highlights importance of Industry 4.0 for Indian Automotive sector and development components that will support India	The report checks the readiness of various countries for Industry 4.0 and focusses on Automobile sector in India and the report does not evaluate the benefits of Industry 4.0 for productivity, quality, cost , safety for Indian Manufacturing companies.
4	India & Industry 4.0 (T.P.Bhat, 2020)	The study highlights adoption and progress of Industry 4.0 in some leading countries and its impact on employment and Jobs. It also generally covers India's competitive landscape and growth potential	The research covers India's competitive landscape and progress on Industry 4.0. It does not measure the impact of Industry 4.0 and improvement post implementation

5	Industry 4.0 & India Inc Gearing up for Change (KPMG, All India Management Association, 2018)	The reports give general details on Industry 4.0 and India's preparedness on Industry 4.0. The reports highlights the risk and opportunities available for India in area of manufacturing. The report also covers importance of role of Government for Industry 4.0 adoption.	The report highlights the risk and opportunities available for India in area of manufacturing and also highlights importance of role of Government. It does not have in its scope the real time application of key components of Industry 4.0 and measure the benefits from it. It also does not have in scope the key criteria for decision making on implementation for Industry 4.0
6	Challenges & Solutions for Digital Transformation (Markus K, 2014)	The study investigates the extent to which swiss manufacturing companies have already positioned in relation to digital transformation and the opportunities the switch to Industry 4.0 offers them. It also covers Industry 4.0 Definitions and Solutions	The report focusses on the swiss manufacturing companies and opportunities available for the swiss companies. It does not have in scope the challenges and benefits for Industry 4.0 in India.
7	A DEMATEL Approach for Evaluation Key Challenges to Industry 4.0 (Ankur A, Sumit G, 2019)	The research evaluates the key challenges of Industry 4.0 in the Indian context. It also uses decision-making trial and evaluation laboratory (DEMATEL) approach to establish relations between the key challenges.	The research evaluates the key challenges faced by Industry 4.0 and does have in scope the benefits and advantages of Industry 4.0. Also it does not cover study of some of the components of Industry 4.0
8	How has Industry 4.0 Shaped up in India (Shristi D, 2017)	The report gives comment on impact of IOT in Industry 4.0 and challenges faced by Industry for adopting Industry 4.0. It also does in general coverage of role of	The report does general coverage of Industry 4.0 and challenges faced by the industry along with government policies. IT does not cover decision criteria and what

		government policies related to Industry 4.0 in India	companies should evaluate while implementing Industry 4.0.
9	Transforming The Manufacturing Landscape (Grant Thornton, 2018)	The report gives view to general impact of Industry 4.0 on Manufacturing Segment and actions taken by various countries towards Industry 4.0. The report also covers India's Competitive Advantage and steps that can make India a major manufacturing hub	This study does not cover the real time application of key components of Industry 4.0 and its benefits. Also the benefits of key components of Industry 4.0 for Auto ancillary and allied companies is not covered.
10	Industry 4.0: Reinvigorating ASEAN Manufacturing for the Future (Imanol A, Vivek L, McKinsey, 2018)	The report covers opportunity for ASEAN Countries for Industry 4.0 and general perceptions on the Ground. The report then gives inputs on overcoming Barriers and accelerating Adoption in ASEAN Countries	The study has been done primarily for ASEAN countries on overcoming barriers and accelerating adoption. It does not have India as the scope of the report. It also does not cover the benefits arising out of Industry 4.0 in the scope
11	New Industrial Revolution in Canada (Pierre-Olivier B, 2017)	The study has taken look at how Canadian small and medium-sized businesses are adapting to this new Industry 4.0 revolution, and report also offers valuable insights and recommendations to help make digital transformation a successful one in Canada	The study covers Canada as a country and other countries including India is not in scope. It does not cover benefits for the auto ancillaries and allied companies.
12	Gearing Up Education towards Industry 4.0 (Krishnan U, Igor J, Debra F, 2018)	The study covers general benefits of Industry 4.0 and its demand on education and Pedagogical Developments. It also highlights the importance quick action by	The study views the Industry 4.0 from view of education and pedagogical developments while it does not have in scope the benefits of Industry 4.0 and input

		education system to train on new technologies	from those who have implemented Industry 4.0
13	An Overview of Industry 4.0: Definition, Components, and Government Initiatives (Shu Tay, Lee C, A.H.Nor Aziati, 2018)	Paper discussed the general definition of Industry 4.0 and its key components. Additionally, government initiatives by various countries toward Industry 4.0 is also presented in this paper.	. It does not have India initiatives in scope and nor does it cover the benefits of Industry 4.0 including productivity, quality, maintenance for auto ancillaries and allied companies
14	Mass Customization in the Context of Industry 4.0: Implications of Variety-induced Complexity (Miroslav M, Slavinor B, 2016)	This research aims to outline all aspects of special issues of economy and complexity arising in mass customization as a strategy. Firstly, it discusses direct economic aspects of mass customized manufacturing with impact on product and process variety-induced complexity.	The scope of the report involves to measure the product and process complexities and the report does not cover the benefit of key components of Industry 4.0 and it's impact for different size of companies.
15	Industry 4.0: Basic understanding and readiness of India (Chirag K, 2020)	The report covers basic Understanding of Industry 4.0 along with India's general preparedness to implement Industry 4.0. It also highlights Six-Dimensional Model to measure Readiness and India's Competitive Advantage	It does not have in scope the study of benefits of Industry 4.0 and real time application of some of the key components of Industry 4.0. It also does cover the impact of key components of Industry 4.0 for auto ancillaries and allied manufacturing companies
16	Digital transformation priorities of India's discrete manufacturing SMEs (Gautam Datta,Ravinder Kumar,	This paper intends to study the functional areas which can potentially leverage Industry 4.0 technologies and help India's manufacturing establishments to transform. It does so in context of	The study draws its context from relevant literature review intended to examine the academic articles published until the end of September 2018, followed by a maturity assessment survey of

	Rahul Sindhwani, Rajesh Singh,2020)	the aspirations of India's Small & Medium discrete Manufacturing Establishments (SMME) towards adopting digital technologies for the identified functional areas.	Indian SMMEs to establish priority areas and does not have in scope to measure the benefits of Industry 4.0
17	How Industry 4.0 can help India escape the Western labor-productivity paradox (Kunwar S, 2018)	The study concentrates on labour stagnation and productivity and highlights that in many of the largest advanced economies, labor productivity rates have stagnated for years. India can avoid repeat of stagnation experience and Industry 4.0 may provide the way out.	The study concentrates on labour stagnation and how industry 4.0 may provide a way out. It does not measure the productivity benefits and other benefits like quality, maintenance, delivery, safety and benefits of key components of Industry 4.0
18	Fourth Industrial Revolution (Klaus S, World Economic Forum, 2016)	The report covers basic general understanding of Industry 4.0 along with opportunities and challenges. It also covers megatrends and impact of Industry 4.0 on economy and business. It also throws brief light on impact on job and related fear. Finally, the report ends with the way forward	The report covers basics of Industry 4.0, megatrends and its impact on employment. It does not have India in its scope and the report does not evaluate the benefits of Industry 4.0 for productivity, quality, cost, safety for auto ancillaries and allied manufacturing companies.
19	Industry 4.0: Overview, Practices and role of Management accountants (Batani Raghavendra R,2019)	The paper has four sections: Overview of Industry 4.0, initiatives and practices, role of management accountants and conclusion. The study is based on secondary sources like reports, surveys, whitepapers, and research articles	The study is based on secondary sources and covers the role of management accountants in driving Industry 4.0. It does not have in scope the benefits of Industry 4.0 and its impact for different size of companies

20	Industry 4.0 Readiness: Evidences from India (Bikram S, 2019)	The paper tries to look into India's readiness towards Industry 4 through evidences from the companies operating in India. The paper also highlights that the companies who have adopted Industry 4.0 have made improvements in processes, structures and routine	The report does not have in scope the productivity, quality, maintenance, safety, delivery, data management benefits of Industry 4.0 for auto ancillaries and allied manufacturing companies. It also does not cover the impact of key components of Industry 4.0 depending on size of company.
21	Industry 4.0: Study of Innovative Journey from Germany to India (Pankaj K, 2019)	This article is an attempt to study the innovative journey of industry 4.0 form its origin in Germany and now scope in India. The report also highlights that beyond the changes in processes, major changes are also expected in the workforce role as new skills are required.	The article does not cover the benefits of key components of Industry 4.0. It does not include the feedback from the industry on their willingness to adopt and also does not provide inputs from companies which has adopted Industry 4.0
22	Industry 4.0: Leveraging of efficiency, adaptability and productivity (Yuvaraj H, 2019)	The report highlights that Industry 4.0 is a gradual shift from Manual tasks to Automated tasks and then to Autonomous systems. It takes few case studies of implementation of Industry 4.0 globally. The report also highlights upskilling initiatives taken by few organizations in India.	The report mentions about the shift from manual systems to autonomous systems along with few examples of implementation in India. It does not have in scope the decision criteria and study of benefits of key components of Industry 4.0

Despite of several studies on the subject very little has been studied on Impact of Industry 4.0 on Performance of Indian Auto Ancillaries & Allied Manufacturing Companies

Research Gaps:

- Limited studies on Impact of Industry 4.0 on Performance of Indian Auto Ancillaries & Allied Manufacturing Companies are conducted so far.
- The several studies done do not study the impact of all components of Industry 4.0 on performance of auto ancillary companies.
- Impact of key components of Industry 4.0 on performance of auto ancillary companies has not been studied.
- Earlier studies do not consider the impact of key components of industry 4.0 according to the size of the company.

From review of literature, it is observed that out of 22 reviews, most of the reviews are related to scope, benefits, opportunities and challenges of Industry 4.0. These research studies are for overall industries and not sector specific. Impact of Industry 4.0 is not similar for all sectors. It is interesting to study the impact of industry 4.0 on Performance of specific sector which is being attempted through this study.

3.0. Research Methodology

The research method is based on qualitative and quantitative research, which focuses on measuring factors to be considered for adopting Industry 4.0 for Indian Manufacturing companies. The intent is to gain an understanding of all the stakeholders on their willingness to adopt Industry 4.0 and expected benefits. Also, the challenges which came their way and the road ahead.

3.1. Research Objectives

1. To identify the key components of Industry 4.0 applicable to Auto Ancillary Companies and Allied Manufacturing Companies.
2. To study the impact of all components of Industry 4.0 on performance of Auto Ancillary Companies and Allied Manufacturing Companies.
3. To study the impact of key components of Industry 4.0 on performance Auto Ancillary Companies and Allied Manufacturing Companies.

4. To study the impact of key components of industry 4.0 according to size of the company for Auto Ancillary Companies and Allied Manufacturing Companies.
5. To study the performance of Auto Ancillary Companies and Allied Manufacturing Companies according to size of company.

3.2. Hypothesis of Study:

1. Null Hypothesis H_{01}: All components of Industry 4.0 are equally implemented in Auto Ancillary Companies and Allied Manufacturing Companies.
   Alternate Hypothesis H_{11}: All components of Industry 4.0 are not equally implemented in Auto Ancillary Companies and Allied Manufacturing Companies.

2. Null Hypothesis H_{02}: There is no impact of components of Industry 4.0 on performance of Auto Ancillary Companies and Allied Manufacturing Companies.
   Alternate Hypothesis H_{12}: There is an impact of components of Industry 4.0 on performance of Auto Ancillary Companies and Allied Manufacturing Companies.

3. Null Hypothesis H_{03}: There is no impact of key components of Industry 4.0 on performance of Auto Ancillary Companies and Allied Manufacturing Companies.
   Alternate Hypothesis H_{13}: There is an impact of key components of Industry 4.0 on performance of Auto Ancillary Companies and Allied Manufacturing Companies.

4. Null Hypothesis H_{04}: There is no association between components of Industry 4.0 and size of company.
   Alternate Hypothesis H_{14}: There is an association between components of Industry 4.0 and size of company.

5. Null Hypothesis H_{05}: There is no significant difference in performance of Auto Ancillary Companies and Allied Manufacturing Companies according to size of company.
   Alternate Hypothesis H_{15}: There is a significant difference in performance of Auto Ancillary Companies and Allied Manufacturing Companies according to size of company.

3.3 Research Design:

No.	Description	Description
1	**Type of organization**	Private auto ancillary and allied manufacturing companies
2	**Universe of the study**	Indian auto ancillary and allied manufacturing companies
3	**Units of observation**	Users/ Leaders/ Managers of Indian auto ancillary and allied manufacturing companies
4	**Sample Size**	150 (User Group- 80, Decision Maker Group- 40, Opinion Makers - 30)
5	**Type of Sampling**	Non-Probability Purposive Sampling & Quota Sampling

3.4. Research Methodology:

Study will be based on secondary and primary data.

Secondary Data:

The following sources will be used to collect secondary data:

1. Books
2. Articles published in newspapers and magazines.
3. Research Journals published in various journals such as EBSCOhost, ProQuest, SAGE Publications, Scopus.
4. Reports of auto ancillary manufacturing industries

Primary Data:

Structured questionnaires will be used to collect primary data. A list of questions will be compiled in a systematic manner. The questionnaire will include company profiles as well as information on independent and dependent variables.

3.5. Independent and Dependent Variables:

The following are the Independent Variables derived from Components of Industry 4.0:

1. Robotics and Artificial Intelligence (AI)
2. Big Data
3. Augmented Reality
4. Additive manufacturing (3D Printing)
5. Cloud Computing
6. Cybersecurity
7. Internet of Things (IoT)
8. System Integration
9. Simulations

The Dependent variables derived from Financial and Quality performance industry 4.0 are as follows:

1. **Financial performance**
   A. Cost of Production
   B. Revenue
   C. Profitability

2. **Quality Performance:**
   A. Quality of product
   B. On time delivery
   C. Acceptance or Rejection
   D. Safety

3.6. Data Analysis

Information will be collected through questionnaire will be entered into excel sheet using appropriate coding and rating for variable. For analysis of data SPSS software will be used following statistical methods will be applied for analysis of data:

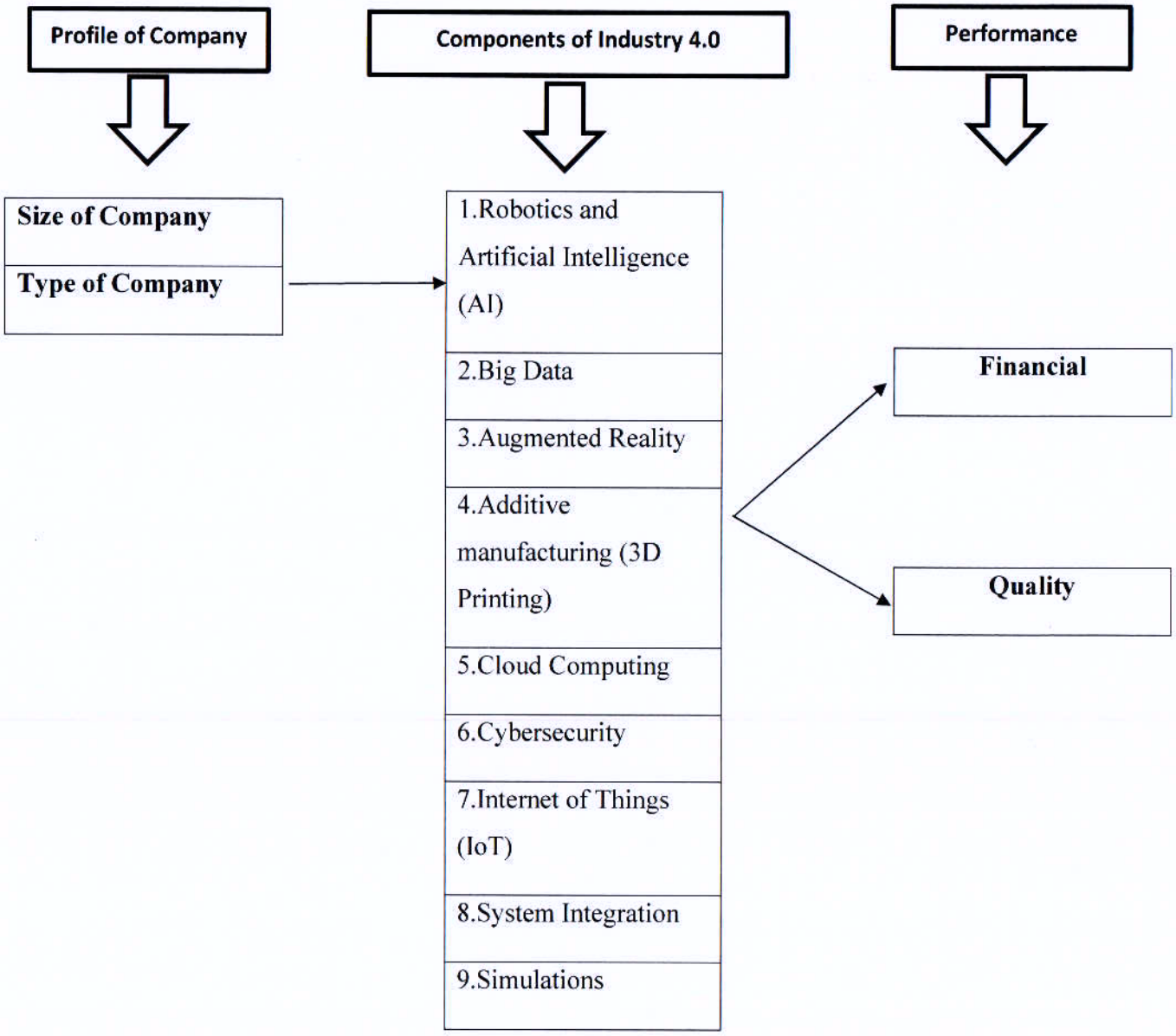
1.Descriptive statistics

In this method statistical tools such as Athematic mean, Standard deviations, Variance will be obtained.

2.Inferential statistics

In this section test of reliability of scale will be verified using Cronbach Alpha test. ANOVA and F-test will be applied to test significance of difference of variables according to profile of company. T-test will be applied to compare variables. Pearson's correlation will be applied to study impact of components of industry 4.0 on performance. If regression model is applicable then it will be developed to estimate performance.

3.7. Research Diagram:



Size of Company = Small, Medium, Large

Types of Company = Auto ancillary, Allied Manufacturing Company

3.8. Limitations of the Study

1. Study is limited to Indian Auto and Allied Manufacturing Companies.

2. Financial performance studied on the basis of information given by the respondents.

4.0. Chapter Scheme

The Chapter Scheme for the proposed research work will be as follows:

1) Abstract
2) Table of contents
3) Introduction
4) Significance of the Study
5) Objectives of the Study
6) Literature Review
7) Statement of Problems
8) Statement of Hypothesis
9) Research Methodology
    a) Research design
    b) Sources of Data
    c) Sampling Techniques
    d) Limitations of Research
10) Analysis of Data
11) Conclusions
12) Scope of Future Research
13) References
14) List of Tables
15) List of Figures
16) List of Publications

5.0. Timelines of Research Study

Chapters	Description	Timeline Tentative (38-40 months)
Chapter 1	Introduction	2 months
Chapter 2	Review of Literature	3 months
Chapter 3	Conceptual Framework	3 months
Chapter 4	Research Methodology	8 months
Chapter 5	Tabulation of Data Analysis & Interpretation	12 months
Chapter 6	Observation & Research Findings	5 months
Chapter 7	Appendix & Synopsis	5 months

6.0. Expected Results

For Organizations:

- The vision and mission of an organization can get aligned to its Modernisation plans.
- Feasibility for Implementing Industry 4.0 in India for auto ancillary and allied companies.
- Improved competitiveness for the organization and stronger global presence.
- Sustenance of organization in the dynamic business environment.
- Derive the key components, auto ancillaries and allied components must consider for Implementing Industry 4.0 in India.
- Outcomes by Implementing Industry 4.0 for auto ancillaries and allied companies.
- Auto Ancillary organizations of different sizes can align their manufacturing digitization plan.

For Society and Country:

- India can position itself as a Manufacturing Hub with improved productivity and competitiveness.
- Economic growth shall be visible with higher productivity and overall growth of manufacturing sector.
- Skill development opportunities.

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